

**Implementation Guidance to the
USEPA Region 2 Draft Interim Policy on Identifying EJ Areas
June, 1999**

Part III: APPENDICES

**Implementation Guidance to the
USEPA Region 2 Draft Interim Policy on Identifying EJ Areas
Part III: Appendices**

A. Data Extraction Tools (GIS and Census Pull Techniques)	A-3
A.1. Alternative Methodologies	A-3
A.2. Use of GIS for EJ Analyses	A-5
B. Region 2 GIS Data	A-13
C. Reviews of Recent EJ Studies	A-18
C.1. Review of Cutoff Points or Decision-criteria Used in EJ Studies	A-18
C.2. Summary of EJ Studies and Their Selected Methodological Characteristics	A-45
D. Special Considerations	A-51
(Also Appendix A of the Interim Policy)	

APPENDIX A. Data Extraction Tools

Appendix A.1. Alternative Methodologies

This section describes a couple of alternative procedures for extracting Census data for the purpose of conducting an EJ analysis. The objective of the extraction is to identify and aggregate data units in a particular geographic area once some data unit such as a Census Block, Block Group or Tract has been chosen as the unit for which data is defined.

a. Non-GIS Techniques - Centroid Pull

An extraction procedure that does not involve a GIS program has been called the “Census Centroid Pull” procedure. This procedure has been identified and tested against other extraction methods by the U.S. EPA.* This procedure involves pulling the Census data units, such as a Block or Block Group, whose centroids fall within some stated distance from a point. The distance is incorporated into a program that is applied to a database program such as Microsoft Access. The outer boundary of the geographic area that results is uneven, since it is the outer boundary of the Census units rather than the boundary of some predetermined geographic unit such as a circle. It will include the entire area of data units whose centroids fall within the distance criterion even though portions of the area of the data units fall outside of the distance criterion. It will not include data units whose area partially fall within the distance criterion, but whose centroid falls outside the distance criterion. The advantage of the technique is its greater speed relative to GIS techniques.

*F. Mynar II and K.A. Hammerstrom, “Population Estimation for Risk Assessment: A Comparison of Methods,” Las Vegas, Nevada: U.S. Environmental Protection Agency, Office of Research and Development, Environmental Monitoring Systems Laboratory, August 1990. EPA 600/X-90/199. Contract No. 68-03-3245.

b. GIS¹ Methods

i. Centroid Pull

A GIS may also be used to perform a centroid pull procedure as described above.

ii. Census Polygon (Clip)

In this method, the GIS is used to “clip” the population data in each census data unit (e.g., block group) represented by polygons that fall fully or partially within a stated distance from the point of interest (e.g., facility). The areas of the clipped polygons are then calculated and

¹ See **Appendix A.2.** for a description of a GIS.

multiplied by the population densities of the block groups from which they were originally clipped to estimate the population for the portion of each block group in the study area. Finally, the estimated total population for the study area (e.g., impact area) is calculated by summing the populations of the individual clipped polygons inside the study area. This method assumes that the populations are evenly distributed throughout the individual polygons (or block groups).

iii. Thiessen Polygon

The Thiessen polygon method estimates the population in a similar fashion as the census polygon method. However, it uses Thiessen polygons to approximate the boundaries of the block group polygons. The Thiessen polygons are constructed around a point, such as a census centroid (center point of a census unit). Finally, the total population in the study area is estimated using the procedures described above for the census polygon method.

iv. Polygon Pull

This procedure involves pulling population data for each block group polygon that falls fully or partially within a specified distance from a point of interest (e.g., one-mile radius). Unlike the census polygon method, which clips the block group polygons that fall partially inside the study area boundary, this procedure uses population information for the entire block group even though the block group is intersected by the boundary of the study area. The total population of the study area is estimated by summing the populations of the block groups that fall fully and partially within the study area. As in the case of the centroid pull procedure, the outer boundary of the geographic area that results is uneven, since it is the boundary of the block groups intersected by the study area boundary.

APPENDIX A.2.

Use of GIS for Environmental Justice (EJ) Analysis

a. What is a Geographic Information System?

A GIS is a sophisticated computer system that, among other things, allows the user to conduct computer-intensive analyses of a variety of geographically related data sets, and then display the results in charts, statistical graphics, or maps at different geographic scales and projections, combining the different types of information into a single image. The GIS does not store maps, but it stores the data needed to conduct analyses and produce the maps, which can be drawn to suit a particular purpose. A GIS database can include geographic, environmental, cultural, demographic, statistical, and political data. Examples of sources of this data include hard-copy maps, aerial photographs, satellite images, censuses, environmental monitoring records, and meteorological records. Each different type of information (roads, geology, population, pollution) is called a layer. GIS allows the user to select from among these various data layers to produce maps that overlay all or a selected subset of them. This, in turn, allows the user to view the spatial interrelationships of all the different characteristics of an area, all in maps specifically produced, scaled, and colored for the specific purpose.

b. Application of GIS to EJ

Although GIS is an effective tool for evaluating EJ problems, GIS locational data accuracy problems are one of the major challenges to the application of GIS to EJ problems. As a result, it is important to bear in mind that when analyses involving specific point locations are conducted, locational accuracy of the points must be verified prior to conducting any EJ study. Further, it is important that any EJ analysis and maps produced for EJ purposes clearly indicate the limitations of the data and analysis method used, as well as any margin of error involved; the maps themselves should not be used for decision-making without independent verification of important location information (For information about the Region 2 Locational Data Policy, contact Harvey Simon at 212-637-3594).

There are generally four steps in applying GIS to EJ questions:

1. Identify the potentially affected population group or groups and the data needed to characterize and map the geographic scope and characteristics of the population of interest.
2. Identify the important environmental concerns and the data needed to characterize and map the geographic extent of the concerns.
3. Acquire the data to create the database describing the environmental components and the population.
4. Map the geographic extent of the environmental concerns and overlay the population data to identify the population or population groups that fall within the geographic extent of the environmental concerns.

One of the most widely used sources of population data for describing the demographic makeup of populations for EJ/GIS analysis is the 1990 Census of Population and Housing Summary Tape File (STF)² data sets administered by the U.S. Bureau of the Census (see table below, titled **1990 Census Data Available on CD-ROM**). EPA database systems, such as the Toxic Release Inventory System (TRIS), Resource Conservation and Recovery Information System (RCRIS), Permit Compliance System (PCS), and the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), are some of the main sources for facility information used to characterize the risk sources for EJ/GIS applications. This data is available in the Region 2 GIS database (see table below, titled **Region 2 Geographic Information System Data**)

There are at least two levels of EJ/GIS analysis: 1) general demographic screening analysis, and 2) site-specific (facility or other **point** of interest)/area-specific (exposure surface or proximity surface; typically **polygons**) analysis. Data aggregated at the State, county or zip code levels would be suitable for general demographic screening analyses. Data aggregated at the census tract, and preferably, census block group and census block levels would be more appropriate for site- or area-specific EJ analyses (provided the facility location and/or impact data are also accurate). In general, the smaller geographic units (e.g., census block group and census block) may yield more accurate results because the data are less aggregated at these levels than they are at the larger geographic levels and are more specific.

GEOGRAPHIC UNIT	GENERAL SCREENING	SITE/AREA-SPECIFIC
STATE	Yes	No
COUNTY	Yes	No
ZIP CODE	Yes	No
CENSUS TRACT	Yes	Yes
CENSUS BLOCK GROUP	Yes	Yes

² The U.S. Bureau of the Census issues summaries of the decennial census at various "summary levels." The U.S. Census 1990 Summary Tape Files 1A and 3A, the most frequently used electronic data products from the Census Bureau for EJ analysis, are block group level summaries. STF 1A is 100-percent count data and contains population, race, age, and housing information, as well as a limited set of economic or income information. STF 3A is sample data with one in six households being represented; it is a more detailed breakdown of the STF 1A data set because it includes income and educational attainment statistics.

GEOGRAPHIC UNIT	GENERAL SCREENING	SITE/AREA-SPECIFIC
CENSUS BLOCK	Yes	Yes

With respect to the Census STF data sets, consideration must also be given to the accuracy of census demography when selecting census data for conducting EJ analyses because some STF data files are more accurate than others by virtue of the manner in which the Census Bureau compiled them. For example, the STF 1A data set contains 100-count data at the block group level, whereas the STF 3A data set is sample data. Depending on the population data needed, analysts should use the more accurate STF 1A data whenever possible and especially when doing site-/area-specific analyses.

Site-/area-specific EJ analysis can be further broken into at least three types: 1) general demographic analysis, 2) exposure analysis, and 3) risk analysis. As previously mentioned, before general demographic, exposure, or risk analyses can be conducted, one must have good locational data for the environmental concern. A decision rule must also be established to determine which census blocks/block groups around the environmental concern or concerns will be included in the analysis because the block groups/blocks will be intersected by the area being studied so that some portions of some block groups would be located outside of the impact area. Should all of the demographic data for these block groups be included or should only those portions corresponding to the land area be included? There are a number of population estimation tools that can be used to determine which block/block groups will be included. These population enumeration methods are discussed in **Appendix A.1**, titled *Alternative Methodologies*.

Figure 1 is a simplified illustration of a generic screening application of GIS to identify populations that are potentially at risk to environmental justice problems. 1990 Census STF 3A data at the block group level were used for the demographic information. This first stage of the EJ analysis allows the user to see the distribution of low-income and minority communities. Once these communities have been identified, the next step would be to study the spatial relationships between the population groups and some environmental concern or concerns on a generic scale (e.g., state level) or site- or area-specific level.

Figure 2 provides a simple illustration of a site-specific application of GIS to identify the population that is potentially at risk from being exposed to the hazards associated with a TRIS facility. The facility, which represents the environmental concern, is identified and located on the map to show its spatial relationship to the low-income and minority populations identified in the generic screening analysis illustrated in Figure 1. A one mile circular buffer is drawn around the facility to represent the impact area where the hazards associated with the facility are assumed to be the greatest. Everyone living in the buffer zone is assumed to be potentially at risk from being exposed to the maximum hazards associated with the facility. While the maximum potential hazard is assumed to be located within the buffered area, the risks are also assumed to be evenly distributed around the facility. Further, populations and population groups are assumed to be evenly distributed throughout the census block groups themselves. Because census data cannot

be broken into units smaller than census blocks, those census block groups that are touched by or included in the buffer zone are included in the analysis. Consequently, demographic information about people that do not live within the exposure, risk, or impact area are included in the analysis. This problem introduces a margin of error to the analysis and is one of the limitations of the census data.

In the illustrations above, the community of Concern (minority population) was identified first and then the GIS was used to identify the environmental concern (TRIS facility) posing the greatest risk to the population. The analysis may also be done in reverse, where the environmental concern is identified first and then the demographics around the concern are identified. Either way, the process of identifying both the environmental concern, the geographic impact area of the environmental concern, and the affected population or population groups is the general GIS approach. The power of GIS becomes even more evident when there is a need to analyze more than one environmental concern simultaneously because it allows the user to overlay any number of environmental factors, look at where the impacts posed by the factors converge, and identify the affected population or population groups in the combined impact area(s).

c. Available GIS and GIS-Related Tools for EJ Analysis

i. ArcView

ArcView is a GIS software tool developed by Environmental Systems Research Institute, Inc. (ESRI) that enables the user to organize, store, visualize, and analyze spatial information, and disseminate the information in the form of maps, charts and tables for spatial decision making. The analytical component of the ArcView tool allows for the creation of spatial data used to define spatial relationships between two or more data sets. The query function allows the user to investigate the spatial relationships, and the editing tools enable the user to create and edit geographic and tabular data and see the changes dynamically in maps and charts. ArcView version 2.1 is currently available in Region 2. Version 3.0 is expected to be released shortly and Region 2 will acquire this upgrade as soon as it becomes available.

There are plans for developing a customized ArcView application that will provide Region 2 staff with easy access to GIS data available in Region 2 GIS system through drop-down menus. The user will be able to create and print their own maps, charts and tables, as well as perform spatial analyses using the ArcView menu tools.

ii. EJ Application Using ArcView

OPM staff plan to develop an ArcView-based application that will support the framework set forth in this document for identification and evaluation of EJ areas. The application will allow the user to generate statistical reports (tables, charts, and map views) for the defined community of concern and reference areas. The application will be menu-driven and will integrate dynamic links to related help and reference information, such as this document.

iii. Gateway/Envirofacts

Envirofacts is a relational database (linked database) that integrates data from four major EPA program systems: RCRIS, TRIS, CERCLIS, and PCS. It contains data, updated monthly, that is available to the public under the Freedom of Information Act (FOIA). No enforcement or budget sensitive information is contained in the database. Gateway/Envirofacts allows the user to query facility information from the relational database using user-defined parameters. The selected facility data can then be exported to the GIS component of the system where the user can map the selected facilities along with geographic features, and demographic data to perform population analyses.

iv. LandView

LandView is a PC-based publication of information from the EPA and the Bureau of the Census that includes: 1) Pollution sources from various EPA databases, including facilities that discharge pollutants into water, air, or underground; facilities that generate, treat, store, or dispose of hazardous waste; and abandoned toxic waste sites (Superfund sites); and 2) Demographic and economic data from the 1990 Census, including statistics on race, age, and income. This data is presented in a geographic context that includes jurisdictional boundaries (e.g., states, counties, cities and towns, congressional districts, census tracts, census block groups, Indian lands, and metropolitan areas); detailed network of roads, rivers, railroads, and landmarks (from TIGER/Line 92); and watershed boundaries.

LandView provides the user with desktop mapping capabilities for displaying, searching, and identifying map objects from the PC; thematic mapping capabilities for choosing display attributes based on database information; population characterization for any radius around any point in the U.S. and territories; printed maps and reports; and the ability to add new layers of information (i.e., geo-referenced data in dBase format).

LandView is available on a set of 10 compact disks, each containing 1/10th the geographic area of the U.S. Data for the entire U.S. is also available on an 11th CD without the detailed geography from TIGER/Line 92 (e.g., roads, railroads, rivers, block groups).

For a more detailed description of GIS in general, and the Region 2 GIS program in particular, please contact Harvey Simon at (212) 673-3594. Information is also available on the Internet, <http://www.epa.gov/Region2>.

- v. Environmental Load Profile GIS-Based Tool** A GIS- based tool evaluates a number of salient elements that relate to the environmental load of a community. These salient elements would serve as indicators of environmental burden and could provide a consistent basis for comparison between communities. The indicators are constructed using TRI data with OPPT model, facility density and population density, land use derived from MRLC satellite data, ambient air quality data from air monitoring station, enforcement and compliance information from IDEA database . The profile develop a matrix of indicators using consistent methodology and data that can be applied to all areas in the region.

1990 Census Data on CD-ROM

File	Subjects	Geography
P.L. 94-171	Total population; population 18 years and over; total and 18 years and over population of Hispanic origin; total population by race and by Hispanic origin; total housing units.	States, counties, county subdivisions, place (or place parts), census tracts/block numbering areas (BNAs) or tract/BNA parts), block groups, blocks, State and/or county parts of American Indian and Alaska Native areas, voting districts for the district of Columbia and selected States.
STF 1A	Age, sex, race, Hispanic origin, marital status, household relationships, units in housing structure, value, rent, number of rooms, tenure, and vacancy characteristics.	States and their subareas in hierarchical sequence down to the block group level; also, summaries for the State portion of American Indian and Alaska Native areas, whole places, whole tracts/BNAs, whole county subdivisions in selected States; and whole block groups.
STF 1B Extract	All persons, race, Hispanic origin, age, housing units, owner occupied and renter occupied housing units, and householders.	States, counties, county subdivisions, places, census tracts/BNAs, block groups, blocks.
STF 1C	Same as STF 1A.	United States, regions, divisions, States (including urban and rural), counties, places of 10,000 or more inhabitants, county subdivisions of 10,000 or more inhabitants in selected states, metropolitan areas (MAs), urbanized areas, and American Indian and Alaska Native areas.

File	Subjects	Geography
STF 3A	Place of birth, education, ancestry, migration, language spoken at home, disability, journey to work, occupation, industry, and class of worker, income in 1989, year moved into residence, number of bedrooms, plumbing and kitchen facilities, telephone, heating fuel, year structure built, condominium status.	States and their subareas in hierarchical sequence down to the block group level; also, summaries for the State portion of American Indian and Alaska Native areas, whole places, whole tracts/BNAs, and whole block groups.
STF 3B	Same as STF 3A	5-digit Zip Code areas within each State, including county portions of the State.
STF 3C	Same as STF 3A	Same as STF 1C.
TIGER/Line	Digital map data for 1990 census geographic areas, basic map features (streets, rivers, railroads, etc.) and their names, address ranges and Zip Codes (in 345 core metropolitan areas), in the form of 12 record types.	Boundaries of legal areas as reported to the Census Bureau to be legally in effect on January 1, 1990, and the final 1990 census tabulation geographical area codes for those entities and certain statistical areas, such as blocks, census tracts and BNAs.
Census/EEO	Detailed occupation and educational attainment data by age, cross-tabulated by sex, race, and Hispanic origin.	Counties, Mas, and places of 50, 000 or more inhabitants.

File	Subjects	Geography
County Migration	Summary records for all interstate and some interstate county-to-county migration stream, including codes for the geographic area of origin and the area of destination, and selected characteristics of the persons who made up the migration stream.	Counties within States.
Public Use Microdata Sample (PUMS)	Population and housing characteristics from a sample of individual census records; 5-percent sample and 1-percent sample. (File is sufficiently broad to protect confidentiality).	Counties or county equivalents with 100,000 or more inhabitants.

SOURCE: Guide to Census Bureau Data on Compact Disc, 1990 Decennial Census, U.S. Bureau of the Census, Data User Services Division, Washington, DC 20233.

APPENDIX B.

Region 2 Geographic Information System Data

APPENDIX B.

Region 2 Geographic Information System Data

DATA LAYERS	DESCRIPTION	AVAILABLE FOR:
AIR_LOC	AIRS Database monitoring locations	New York and New Jersey
AQUIFERS	Primary and Sole Source Aquifers	New York
CENSUS_EQ	Census STF3-A demographic data	New York, New Jersey, Puerto Rico
CERC_FAC	CERCLIS (Superfund) Facilities	All States
DLG24_H	USGS DLG Hydrology, 1:24K scale line and polygon data	Puerto Rico
DLG100_H	USGS DLG Hydrology, 1:100K scale line data	New York and New Jersey
DLG100_R	USGS DLG Streets, 1:100K	New Jersey
GIRAS_LU	USGS 1:250K scale Land Use data	New York and New Jersey
GNIS_BLDGS	Geographic Names Information System (GNIS) government buildings, churches, hospitals	All States
GNIS_HYD	GNIS hydrologic features	All States
GNIS_PHY	GNIS physical features	All States
GNIS_PPL	GNIS populated places	All States

DATA LAYERS	DESCRIPTION	AVAILABLE FOR:
GNIS_SCH	GNIS schools	All States
HUC_CODE	Hydrologic Unit Codes	New York
ITUM_GEO	Integrated Terrain Unit Map (ITUM) of bedrock geology from NJDEP	New Jersey
ITUM_SOIL	ITUM of bedrock soil from NJDEP	New Jersey
ITUM_FLD	ITUM of flood zones from NJDEP	New Jersey
ITUM_LU	ITUM of bedrock land use from NJDEP	New Jersey
INDEX	County and tile boundaries	All States
LUSE_77	Puerto Rico Department of Natural Resources Land Use	Puerto Rico
MUNI_BND	Municipal Boundaries	All States
NA_RES	Native American Reservation Boundaries	New York
NPL_SITE	Polygon coverage of National Priority List (NPL) sites	All States
PCS_FAC	Permit Compliance System (PCS) facilities	All States
QUAD_BND	USGS 7.5 minute Topographic Quadrangle Boundaries	New York and New Jersey
STATSGO	Soil Conservation Service (SCS) State soils data	New York and New Jersey

DATA LAYERS	DESCRIPTION	AVAILABLE FOR:
STORET	Storage and Retrieval of Water-Related Data system (STORET) monitoring locations	All States
TIGER_ADR	Address matched roads from TIGER	All States
TIGER_BLK	Census blocks with 1990 population data	New York and New Jersey
TIGER_RD	Roads from Census TIGER files	All States
TIGER_RR	Railroads from Census TIGER files	All States
TIGER_TR	Census tracts with 1990 population data	All States
TIGER_SH	Shoreline from Census TIGER files	All States
TRI_FAC	Toxic Release Inventory System (TRIS) facility data	All States
USGS_SOILS	Soils data 1:24K scale digitized by USGS	Puerto Rico
NY_SUGEO	New York surficial geology from NYS Library	New York
NY_BRGEO	New York bedrock geology from the NYS Library	New York
ZIP_CODE	Zip Code boundaries	New York and New Jersey
RASTER DATA		

DATA LAYERS	DESCRIPTION	AVAILABLE FOR:
BATHYMETRY	Bathymetry from National Ocean Survey (NOS) digital bathymetry files - Lake Ontario, NY Bight and Caribbean Sea	All States
PR SPOT	SPOT satellite image	Puerto Rico
ORTHOPHOTO QUADS	Digital Orthophoto Quads (DOQs) for all of PR and parts of NJ	Puerto Rico and New Jersey
QUAD IMAGES	Scanned 1:24K scale quadrangle maps	New York
DEM	1:250K Digital Elevation Model	New York, New Jersey, Puerto Rico

APPENDIX C.

Review of Recent EJ Studies

APPENDIX C.1.

REVIEW OF CUT POINTS OR DECISION CRITERIA USED IN RECENT ENVIRONMENTAL JUSTICE STUDIES

a. Introduction

Since environmental justice arose as a national issue, numerous descriptive and analytical protocols have arisen for displaying demographic and environmental data, analyzing the data, and interpreting it to determine whether environmental justice issues exist. This work has been conducted both within and outside of government. Many of the studies have been exploratory and have not been used as a basis for decision-making.

These studies can provide valuable guidance as to how EJ analyses have been performed in the and what sets of criteria have been used as the bases of EJ determinations. They provide both explicit and implicit protocols for conducting and interpreting region-specific environmental justice analyses.

The following review of recent EJ studies focuses upon a few key attributes that are applicable to the development of Region 2 EPA EJ guidance:

- The selection of impact areas or communities of concern
- The selection of reference areas, and
- the cutoff points used to determine whether or not an EJ issue existed.

The third attribute - cutoff points - is given the most emphasis. Table 1 lists the general characteristics of the studies and the data used in making an EJ determination. Table 2 summarizes the differences in the minority, low-income, and environmental burden factors between community of concern and reference areas (both the absolute and percentage differences).

i. Communities of Concern (or Impact Areas)

The various EJ studies have not defined Communities of Concern in a consistent way. The communities of concern used in non-governmental studies are generally a single Census unit, usually a Tract. The Tract in which the facility is located is often used to define the community of concern. In contrast, governmental studies typically aggregate smaller Census data units, usually Block groups within a certain defined radius (usually one mile) from the site to define the community of concern.

ii. Reference Areas

Alternative reference areas are used by most of the studies. In practically all cases, the State is used as one reference area. Some studies use the larger Census-defined Region (Northeast, Midwest, South and West multi-state regions). In other cases the county is included as a reference area. The municipality is rarely used. Reference areas are also selected at small scales, such as areas immediately adjacent to the Community of Concern.

iii. Cutoff Points

Investigators apply a range of different criteria to demographic data and environmental conditions to evaluate whether an environmental justice issue exists. The differences occur with respect to

- the *form* of the criteria such as the demographic variables selected,
- the *expression* of the criteria, and
- the actual *cutoff* points used for any given criterion.

The *form* of the criteria refers to the kind of population characteristics selected as a basis for an EJ decision. It is recognized that no single population characteristic can be used as a basis for defining environmental justice. Nevertheless, the data presented here are restricted primarily to income or poverty and race and ethnicity of populations near waste sites or exposed to environmental conditions suspected of being adverse. These attributes were selected because they are explicitly mentioned in E.O. 12898, although many of the studies go beyond these indicators in characterizing populations in proximity to adverse environmental conditions. Other restrictions were applied to the scope of this review. The review was confined to issues of site location or proximity, although many of the studies went beyond a focus on characteristics of populations near the sites to the relationship between population characteristics and site attributes, such as cleanup or operational status. Finally, the studies reviewed here are restricted to cross-sectional studies (one point in time), rather than those exploring changes in characteristics over time, although some of the data are shown for alternative time periods.

The *expression* of the criteria refer to how the population characteristics are used to reflect whether or not an EJ issue exists. For example, early studies approached environmental equity in one of two ways. One set of studies calculated and compared the proportion of all waste facilities in a locale that were located in high minority areas vs. the proportion in non-minority areas. Other studies took the opposite approach - for a given area with one or more waste facilities, the proportion of minorities in the area surrounding the facility was compared with minorities in an outlying reference area that did not have facilities. Both approaches are valid, but can lead to different conclusions. Still other approaches use correlation coefficients to relate population characteristics to the number of facilities in different geographic areas.

The actual *cutoff* point refers to how big a difference between a community of concern and a reference area constitutes an EJ issue. This can be in terms of the absolute difference for a particular population characteristic or the percent difference. There is very little consistency

among the studies in the kind of cutoff points used or the magnitude for the differences used to make an EJ determination. In spite of these problems, however, some general tendencies are apparent, which can provide a guide for developing an approach for designing and applying cutoff points.

- Whatever measures are used for population characteristics, the values used in comparisons are typically expressed as percentages or proportions (e.g., % in a given minority category or % below poverty). The absolute differences are rarely reported, and the percentage difference between the value for the community of concern vs. the reference area is almost never reported. Table 2 displays these computations based upon data given in the published studies as a basis for exploring cutoff values. Statistical significance is sometimes used to acknowledge that a difference exists between the characteristics of a community of concern and the reference areas. It is becoming more common, and is an important first step in evaluating differences among studies.
- Whether differences are considered statistically significant or not, researchers almost always regard absolute differences of a couple of percentage points between the community of concern and the reference areas as not sufficient for confirming an EJ issue in the community of concern.
- When differences are assessed (though never computed), conclusions are generally based upon the absolute value of the differences between community of concern and reference area characteristics and not on percentage differences.
- Percentage differences in the absolute values of a population characteristic for the community of concern and the reference area (computed in Table 2) were never reported, even though they can provide a guide to how the two areas differ from one another. The percent differences did not correspond closely to the stated conclusions of the studies. That is, a number of studies concluded that little difference existed between the community of concern and the reference areas based on absolute differences, when, in fact, the percentage differences were quite large.
- The size or magnitude of the baseline values for population characteristics is almost never examined in evaluating an EJ issue, even though it can provide a guide to whether or not such an issue exists.

b. Details of Individual Studies

Anderton, Anderson, Oakes, and Fraser (1994)

The Anderton et al. study contains over a half dozen analyses for Treatment, Storage and Destruction Facilities (TSDF). The results of four of these are shown in Table 1. Demographics are defined or aggregated at the Census Tract level. Each analysis differs in terms of the definition of the comparison area, that is, how far from the site the comparison is located. The authors interpret the first three analyses as showing little in the way of the disproportionate location of minorities or poor in the areas near the sites (actually in the Tracts with sites) relative to areas further away (Tracts without sites). As shown in Table 1, this judgment is based on absolute differences in the percentages between community of concern and reference area characteristics, with those differences usually being less than 2%. The fourth analysis, however, redefines and enlarges the community of concern to include adjacent Tracts, and compares this redefined area to non-adjacent areas further away. On the basis of this, the authors conclude that: “This larger unit of comparison, in fact, produces findings more similar to prior studies based on larger geographic units of analysis. In contrast to results for more refined areas, the average percentages black, Hispanic, below the poverty line, and receiving public assistance are higher in the aggregated areas including and surrounding TSDFs than in the remainder of the SMSAs” (p. 238). Although the authors do not say this, it is possible that the three prior analyses simply defined too small a community of concern, that is, what was defined as comparison areas were really still a part of the community of concern, or impact area of the facility.

Boerner and Lambert (1995)

This work concentrates on the St. Louis area. Several analyses are reported. One analysis addresses the demographics around TSDFs, landfills and incinerators. Another similar analysis adds National Priority List (NPL) sites to these three facility types to see how the results change. Only results of the second analysis are shown in Table 1. The study uses Tract data, and characterizes the demographics of the site as the demographics of the Tract in which each site is located. Comparisons of the aggregated data are conducted for areas with facilities and those without the facilities. Statistical tests of significance are conducted to determine the statistical significance of the differences using t-tests for means, Wilcoxon Rank Sum tests for the equality of the distributions, and Wilcoxon z-scores for the medians.

- **TSDFs, landfills and incinerators**

This comparison reveals that the % minority and % in poverty are the same for areas with and without the three kinds of facilities for three years (run separately) - 1970, 1980 and 1990.

These conclusions are based on absolute differences between the percentages of areas with and without facilities of at most about 3% and usually under 1%.

- TSDFs, landfills and incinerators and NPLs

The authors state that adding NPLs, produces “weak evidence” for more minorities and poor in tracts with the facilities than without the facilities. Weak evidence is interpreted as 1-3% differences in the percentages for minorities and those in poverty in areas with sites than in those without sites (p. 10-11).

Cutter (1996)

Cutter, Holm and Clark (1996) evaluate Toxic Release Inventory (TRI) sites, RCRA TSDFs, and inactive hazardous waste sites (on CERCLIS) within South Carolina. Three different geographic scales are used in the analysis: counties, census tracts, and census block groups. The location of the facility is defined as one of the three geographic units within which it is located, rather than as a latitude/longitude. Two measures of disproportionality were used on data dis-aggregated by type of facility and geographic unit, as well as aggregated for all three types of facilities. These two measures were: the correlation between the demographic characteristic and the number of facilities or sites; and a t-test of significant difference between those geographic units with sites and those without sites. The results aggregated for the three types of facilities are shown for the t-test in Table 1 for race and income variables, and are shown separately for Tract and Block group units.

The results are interpreted as showing a slight disproportionate burden on White, affluent communities within metropolitan communities at the county level, and no association by race and income at the smaller tract and block group units. The authors, however, point out that other measures of inequity do show significant relationships to the presence of sites, namely the presence of children and elderly, laborers and persons with relatively less education.

Greenberg (1993)

Greenberg focuses on waste to energy plants, and conducts about a half dozen separate analyses, varying the comparison areas. Only a few of these are summarized in Table 1. The first analysis compares small and large towns. Differences are expressed both in terms of the difference in the proportion and the difference in the average for the number of towns which exceed the service areas of the waste facilities in % per capita income and % African and Hispanic Americans. The service area is considered the benefit area, whereas the rest of the town would presumably be bearing the cost of the facility without receiving the benefit.

The findings are that only 23.5% of the large towns have town incomes exceeding service area income compared to 60.3% for the small towns. 88% of the large towns have minority populations exceeding the service areas. These are large differences, and lead the author to conclude that: “The larger facility-populous town combination had statistically significant inequities for per capita income and minorities. The smaller facility-less populated town combination had slightly higher per capita income than their service areas and much less minority inequity.” (p. 243)

Hamilton (1995)

Demographic data for Hamilton's analysis of TSD capacity expansions in the U.S. between 1987-1992 are defined at the zip code level. He examines commercial TSDs operating in 1987. The results show a 7% difference in % Nonwhite population and a 3% difference in % of families in poverty in zip code areas with expansions vs. those without expansions. These percentage differences are significant at the .05 and .10 significance levels respectively. These findings lead Hamilton to conclude that: "potential exposure to externalities from future waste processing capacity does vary by race"; no statement is made about poverty or income (p. 123).

Heitgerd, Burg, and Strickland (1995)

This study of NPL sites nationwide was performed within the Agency for Toxic Substances and Disease Registry (ATSDR). It compared population characteristics, restricted to Census categories for race and Hispanic, within a mile of the NPL sites with several comparison areas. One comparison area consisted of the rest of the area of the county within which each site was located. A second comparison area consisted of the Nation. Two separate analyses are performed: one which compares populations living in the counties in which NPL sites are located and within one mile of the NPL site with the county populations and the Nation (Table 1 in the reference); the other compares the same community of concern with a comparison area that is outside the one mile site area but still within the site's county (Table 2 in the reference). GIS is used to extract the data, which is obtained at the Census Block level.

The author's conclude on the basis of statistical analyses of difference on the second comparison that "a significantly higher percentage of minority populations near some of the NPL sites than in the comparison areas" (p. 356).

Hird (1993)

Hird's review of NPL sites nationwide aggregating demographic characteristics at the county level, concludes that "NPL sites are located predominantly in affluent areas, and generally irrespective of race". These findings are based on Tobit and probit analyses. The comparison between mean values for counties with sites and national means for counties is shown in Table 1. The differences between the percentages are about 2% for race and about 5% for income.

Korc (1996)

The Korc study is one of the few that attempts to relate pollutant exposure to demographics. The study is limited to the Southern Coast Air Basin of California (SoCAL). Per capita hours of exposure to ozone exceeding 125 ppb (the NAAQS) are computed for total population in each of the racial and ethnic groups in the district. Ozone is measured for a 10 square km grid (limited primarily by the location of the air monitors).

On the basis of hours of exposure exceeding 125 ppb, all minority populations except Native Americans have fewer hours of exposure than whites in both the 1980 and 1990 periods. Native Americans had higher exposures because they lived in high areas where ozone accumulates. However, Hispanics were exposed to about 4 more per capita hours of ozone than non-Hispanics in 1980, but this was reduced to 2 more per capita hours by 1990. The author concludes that for

the 1990 period “all the race and ethnic groups had similar per capita hours of exposure”, based on maximum differences of 13 per capita hours of exposure (occurring between blacks with the lowest and Native Americans with the highest). Most importantly, the author points out that “ozone exposure differences by race and ethnicity have diminished over time” (p. 555).

A similar analysis is conducted for three per capita 1989 income categories averaged over 10 square km exposure districts: <\$10,000, \$10-20,000, and >\$20,000. The findings for income are more pronounced than for minority status. The authors conclude on the basis of as much as 20 per capita hour differences of exposure between the <\$10,000 and the \$10-20,000 categories for both time periods that: “the set of exposure districts with average per capita income over \$20,000 tended to experience lower number of per capita hours of exposure than the sets of exposure districts with lower average per capita income.” (p. 555) Furthermore, he points out that “on average low income districts may have been experiencing a higher number of per capita hours of exposure to ozone above the NAAQS than high income districts, indicating that environmental health risks (e.g., respiratory diseases) may be systematically higher for low income groups in Southern California.” (p. 556)

Perlin et al. (1995)

Perlin et al. have examined the distribution of TRI sources and emissions relative to demographics. Sources are examined primarily at the level of the 10 EPA regions, while emissions are analyzed at the county level.

TRI (Sources). Perlin et al. examine the distribution of races and income classes by EPA region against the distribution of both the number of TRI facilities and the amount of emissions of all TRI chemicals and 33/50 chemicals (a more toxic, high priority subset). The analysis of the distribution of numbers of facilities is presented in tabular form, but the conclusions are not quantified except that both race and number of facilities are regarded as not being uniformly distributed and a statement is made that “There appears to be no correlation on a regional [EPA region] basis between the median household income and the number of TRI facilities” (p. 72).

TRI (Emissions). Findings on emissions (aggregated by county), race, and income are more quantified comparing total emissions by race or income for a given percentile (with details provided in tables): “With the exception of Native Americans, minority groups tend to live in counties where emissions are higher compared to the emissions in counties where whites live. For example, the 50th percentile of county-level emissions for all TRI chemicals and for the 33/50 chemicals is about twice as high for blacks, Asian/Pacific Islanders, and other races as for whites.” Similarly, at the 90th percentile, county-level emissions are twice for blacks what they are for whites, and four times for Asian/Pacific Islanders, other races, and Hispanics than for whites. (p. 74). Thus, implicitly, a doubling of emissions for a given category implies disparity. The absolute magnitude of the difference in aggregate emissions varies from about 1 million lbs/yr. in the 50th percentile to 8 million lbs/yr. in the 90th percentile for blacks, and more for the other racial categories when compared with whites. Nationwide comparisons between emissions and race and income are conducted using an indexing technique. The results confirm that although racial minorities live in counties with higher TRI emissions, persons with higher incomes live in those

counties as well. The authors explain this in part by the problem of aggregating at the county level.

Ringquist (1995, 1997)

Ringquist has conducted two analyses - one of TSDFs and the other of TRIs. Both are nationwide studies.

TSDFs (Sources). Ringquist extends the UCC (1987) study by evaluating all TSDFs nationwide rather than just commercial TSDFs. He uses the same zip code level of analysis to be comparable to the UCC study. He concludes that an absolute difference of 4% in the % minority between zip code areas with no TSDFs (aggregated nationwide) and those with at least one TSDF constitutes inequity. No difference was found in % poverty for zip code areas with different numbers of TSDFs.

TRI (Emissions). In evaluating the emissions of TRI facilities, Renquist concludes that a greater than doubling in the pounds of emissions in areas with >5% minorities (absolute value of over 10,000 pounds in a 5 year period) constitutes inequity. No difference was found for poverty. In fact, emissions were less in areas with greater proportions of the population in poverty.

Zimmerman (1993)

This is a nationwide study of approximately 1200 NPL sites, constituting all sites on the NPL in the early 1990s in towns whose populations exceeded 2,500. Demographics are defined at the level of the municipality in which the site is located (the smallest municipal designation, which is the Census Place or Minor Civil Division).

The conclusions of this study, based upon weighting municipalities by the size of their populations are that “With respect to site location, the percentage of Blacks and Hispanics aggregated at the Census Place or MCD level in communities with NPL sites was greater than is typical nationwide (Largely attributable to the concentration of minority populations in a few large urban areas with NPL sites). In contrast, the percentage of the population below the poverty line in communities with NPL sites largely matched that of the nation as a whole.” (abstract) These conclusions are based upon (1) a difference in the % Black between the communities with NPLs and the Nation of about 6% or a percentage in NPL communities that is 50% greater than the percentage in the Nation, and (2) a difference of about 4 % for Hispanics also constituting about 50% greater than the percentage for the Nation.

Zimmerman (1994)

This is a study of 200 NPL sites in New York and New Jersey. Demographics are defined at alternative distances from 1 to 4 miles from each site’s latitude and longitude, and are aggregated at the Census Block level. The findings were: “areas within about one mile of the sites had, on average, lower house values and rents than was typical of the states within which the sites were located. Other socioeconomic characteristics that were studied -- including racial demographics -- differed little, on average, from statewide characteristics.” The study underscored the fact that, in spite of the averages, extreme values exist that potentially signal environmental justice issues.

Zimmerman (1996)

This is a study of about 3,000 non-NPL sites (on the CERCLIS inventory) in New York and New Jersey. Demographic characteristics are defined within one mile of each site's latitude and longitude, and are aggregated at the Census Block level. Conclusions with respect to proximate populations from this study are when demographics of non-NPL site areas are compared to states [The mean values of NJ/site and NY/site characteristics respectively are indicated in brackets]: "Population density near the sites is many times higher [1035/6679 and 380/5096 persons per square mile], the percentage of Native Americans near sites is somewhat higher [0.19%/0.3% and 0.35%/0.5%], and house values [income surrogate] are substantially lower than statewide averages [\$185,300/\$156,890 and \$158,300/\$111,670]." Otherwise, the percentages of minority populations around the sites is the same or lower than the State averages (from Tables 1 and 2 of the report).

When site demographics are compared to county characteristics: "With respect to site density by county, every county contains a non-NPL site, but sites are concentrated in counties in older industrial areas . . . Population characteristics near sites are similar to their county characteristics. Except for %Native American, correlations of county and site characteristics were extremely high - close to 1.0".

TABLE C.1.1
SELECTED CUTOFF POINTS USED IN ENVIRONMENTAL JUSTICE STUDIES

1	2	3	4	5	6	7
Author(s)	Date	Facility	Scope	Characteristic	Comm. of Concern	Ref. Area
A. STUDIES CONFINED TO SPECIFIC GEOGRAPHIC REGIONS						
Boerner, Lambert	1995	TSDF, landfills & incin. NPLs	St. Louis	%Minority 1970 1980 1990 %Poverty 1970 1980 1990	Tract with facility 13.8 16.4 18.3 17.8 26.5 32.0	Tract without facility 11.6 12.8 15.0 17.2 25.1 28.9
Cutter, Holm, and Clark	1996	TRIs, TSDs, inactive waste sites	South Carolina	All facilities: %Non-white %Below poverty Med\$HH income %Non-white %Below poverty Med\$HH income	Tract with facility 33.5 16.2 \$25,324 Block group with facility 33.6 16.5 \$25,137	Tract without facility 32.4 15.9 \$26,644 Block group without facility 31.4 15.9 \$26,938

1	2	3	4	5	6	7
Author(s)	Date	Facility	Scope	Characteristic	Comm. of Concern	Ref. Area
Korc	1996	Districts exceeding ozone NAAQS (n=142 in 1990 - 1992)	SoCAL	Per Capita Hrs Exposure to Ozone >125 ppb (NAAQS) (1990-1992) 75% (Hrs.)	Non-white B: 23.9 hrs. A: 27.5 NA: 36.4 O: 28.8 <\$10,000 58.1 hrs. \$10-20,000 76.6 hrs.	White 33.9 hrs. >\$20,000 36.3 hrs.
Mohai & Bryant	1992	Hz TSDFs	Detroit	% Minority % Poverty	<1 mile: 48% 29%	>1.5 mi.: 18% 10%
U.S. GAO	1983	Comm. TSDF (n=4)	S.E. U.S. (Mun.)	% Minority % Poverty	TSDF areas: 38% 52 66 90 >26%	No TSDFs: 20% 26%
Zimmerman	1994	NPLs n=200	NY, NJ (Block)	%Black House value	Within 1-mile 7% \$160,504/ \$128,341	NJ/NY 13.4/15.9% \$185,300/ \$158,300

1	2	3	4	5	6	7
Author(s)	Date	Facility	Scope	Characteristic	Comm. of Concern	Ref. Area
Zimmerman	1996	non-NPL sites n=3000	NY, NJ (Block)	NJ %Black %Native Am. House value NY %Black %Native Am. House value	Within 1-mile 13.5% 0.3% \$156,890 6.7% 0.5% \$111,670	Statewide 13.4% 0.19% \$185,300 15.9% 0.35% \$158,300

1	2	3	4	5	6	7
Author(s)	Date	Facility	Scope	Characteristic	Comm. of Concern	Ref. Area
B. NATIONWIDE STUDIES						
Anderton et al.	1994	Comm. TSDFs open in 1990; n=408	U.S. in metros (Tract)	All metropolitan areas: %Black %Hispanic % Below poverty	TSDF Tracts 14.5% 9.4 14.5	Tracts without TSDFs 15.2% 7.7(p<.1) 13.9
				25 largest metro. areas: %Black %Hispanic % Below poverty	TSDF Tracts 12.2% 13.9 12.5	Tracts without TSDFs 16.4%(p<.05) 10.1(p<.05) 13.5
				Surrounding areas (at least 50% of Tract is 2.5 mi. of site) %Black %Hispanic % Below poverty	TSDF Tracts (all metros) 14.5% 9.4 14.5	Surrounding areas 25.7%(p<.01) 10.8 19.5(p<.01)
				%Black %Hispanic % Below poverty	TSDF and Surrounding Tracts 24.7% 10.7 19.0	Non-adjacent Tracts 13.6%(p<.01) 7.3(p<.01) 13.1(p<.01)

1	2	3	4	5	6	7
Author(s)	Date	Facility	Scope	Characteristic	Comm. of Concern	Ref. Area
Greenberg	1993	WTEFs (n=92)	U.S.- service area	% of towns with higher income than service area % of towns with higher minority than service area	100,000+ pop., >1000 tpd 23.5% 88.2%	>25,000 pop., <1000 tpd 60.3% 43.1%
Hamilton	1995	Comm. TSDFs (n=207)	U.S. (zip code)	%Nonwhite %Poverty	With TSDF expansion 25% (p=.05) 14 (p=.10)	Without TSDF expansion 18% (p=.05) 11 (p=.10)
Heitgard, Burg and Strickland	1995	NPL	U.S.	Table 1 of ref. %Black %Hispanic Table 2 of ref. %Black %Hispanic	1-mile radius 10.3 14.4 9.4 4.3	All other areas in site county 12.1 9.0 8.3 4.0
Hird	1993	NPL	U.S. (county)	% Nonwhite %Poverty	Counties with NPLs 10.2 (S.D. 10.14) 10.57 (S.D. 4.68)	National mean for counties 11.89 15.78

1	2	3	4	5	6	7
Author(s)	Date	Facility	Scope	Characteristic	Comm. of Concern	Ref. Area
Perlin et al.	1995	TRIs	U.S. (county)	Aggregate Emissions (000s lb) 50 %ile (county emissions) 90 %ile (county emissions)	Minority B:2066 NA:466 AP:2205 O:2356 H:1874 B:16484 NA:5568 AP:28139 O:29789 H:29115	White 1162 7826
Ringquist	1995 1997	Comm. TSDF	U.S. (Zip)	%Minority % Poverty	TSDF areas: 1+: 19% 5+: 28% 1+: 15% 5+: 16%	No TSDFs: 11% 16%
Ringquist	1995	TRI emiss.	U.S. (Zip)	Aggreg. 1987-1991 emissions (in 000s lbs.)	Hi Minority 5-25%: 20.2 >25%: 24.3 High Poverty 5-25%: 12.6 >25%: 17.0	Low Minority <5%:10.1 Low Poverty <5%:18.0
UCCCRJ	1987	Comm. TSDF	U.S. (Zip)	% Minority	TSDF areas: 1+: 24% 2+: 38%	No TSDFs: 12%

1	2	3	4	5	6	7
Author(s)	Date	Facility	Scope	Characteristic	Comm. of Concern	Ref. Area
Zimmerman	1993	NPLs	U.S. (municipality)	% Black % Hispanic % Poverty	Pop. weighted average for Site municip. 18.7% 9.0% 14.0%	U.S. 12.1% 13.7% 12.4%

NOTES:

Abbreviations:

Minority groups: A=Asian, B=Black, NA=Native American, AP=Asian Pacific Islander, O=Other;
H=Hispanic; Min.=minority.

NAAQS: National Ambient Air Quality Standards (under the Clean Air Act)

SoCAB=South Coast Air Basin of California

TRI: Toxic Release Inventory facilities

TSDF: Transfer Storage and Disposal Facility (as regulated under the Resource Conservation and Recovery Act)

In the Anderton et al (1994) study, where statistically significance is not indicated, the difference is not statistically significant at the $p < .1$ level.

Cutter, Holm, and Clark (1996) results are not significantly different, except for median household income, which is significant at the $p < .05$ level.

Greenberg (1993) gives confidence intervals and conducts statistical tests of significance for the differences. The service area is considered a benefit area. This is one of a half dozen findings presented using different statistics and comparison areas.

Heitgerd, Burg, and Strickland (1995) results for the second analysis are shown to be statistically significantly different using ANOVA.

Perlin et al.(1995): Figures shown are only the results for all TRI chemicals. A similar table is given in the paper for just the 33/50 high priority TRI chemicals.

Ringquist (1997) also gives minority % disaggregated for African Americans and Latinos for No sites, 2+, and 5+ TSDFs. African American %s are 7%, 12%, and 15% respectively and Latino %s are 4%, 7% and 9% respectively. Figures shown for minority populations in areas with more than 1 and more than 5 TSDFs are based on correspondence with author, 10/8/96.

The figures and interpretations for the UCCCRJ study are drawn from Ringquist (1997: 238).

Zimmerman (1993) figures for %poverty are compared for 1980 rather than 1990, because of data availability at the time of the study for %poverty.

TABLE C.1.2
MAGNITUDE OF THE DIFFERENCES BETWEEN
COMMUNITY OF CONCERN AND REFERENCE AREA POPULATION CHARACTERISTICS
FROM SELECTED ENVIRONMENTAL JUSTICE ANALYSES

NOTE: Differences are reported only where the community exceeds the reference area in the prevalence of minority or low income populations. A dash (-) indicates the opposite relationship or no relationship was found, i.e., reference area exceeded target area.

Author(s)	Measure	Absolute Difference	Percent Difference	Author Inference
Regional Studies				
Boerner, Lambert	%Minority			Most differences considered small or statistically insignificant.
	1970	2.2	19.0	
	1980	3.6	28.1	
	1990	3.3	22.0	
	%Poverty			
	1970	0.6	3.5	
	1980	1.4	5.6	
	1990	3.1	10.7	
Cutter, Holm, and Clark	All facilities:			“At both the census tract and block group levels, there is no association between race and the location of toxic/hazardous waste facilities. There are slight differences in the income levels between tracts and block groups with facilities and those without.”
	<u>Tract level</u>			
	%Non-white	1.1	3.4	
	%Below poverty	0.3	1.9	
	Med\$HH income	1320	5.0	
	<u>Block level</u>			
	%Non-white	2.2	7.0	
	%Below poverty	0.6	3.8	
	Med\$HH income	1801	6.7	

Author(s)	Measure	Absolute Difference	Percent Difference	Author Inference
Regional Studies				
Korc	Per Capita Hrs Exposure to Ozone >125 ppb (NAAQS) <u>Race</u> Black Asian Nat. Amer. Other 75% (Hrs.) <u>Income</u> <\$10,000 \$10-20,000	-- -- 2.5 -- 21.8 40.3	-- -- 7.4 -- 60.1 111.0	Findings primarily significant for low income areas.
Mohai & Bryant	<1mi./>1.5 mi. % Minority % Poverty	30.0 19.0	166.7 190.0	Closer areas considered to have substantially higher minority and low income people.
U.S. GAO	<u>TSDf/no TSDf</u> % Minority Area 1 Area 2 Area 3 Area 4 % Poverty	18.0 32.0 46.0 70.0 -- --	90.0 160.0 230.0 350.0 -- --	TSDf areas considered to have substantially higher minority and low income people.
Zimmerman	<u>1 mi./State</u> %Black House val(\$) NJ NY	-- 24796 29959	-- 13.4 18.9	House value considered substantially depressed near sites

Author(s)	Measure	Absolute Difference	Percent Difference	Author Inference
Regional Studies				
Zimmerman	<u>1 mi./State</u>			House value considered substantially depressed near sites
	NJ %Black	0.1	0.7	
	%Native Am.	0.1	52.6	
	House value (\$)	28410	15.3	
	NY %Black	--	--	
	%Native Am.	0.15	42.9	
	House value (\$)	46630	29.5	

Author(s)	Measure	Absolute Difference	Percent Difference	Author Inference
National Studies				
Anderton et al.	<u>All metropolitan areas</u> (Tracts with/ without facilities) %Black %Hispanic % Below poverty <u>25 largest metros</u> (Tracts w/w-o): %Black %Hispanic % Below poverty <u>Tract with/ surr. area without facility</u> %Black %Hispanic % Below poverty <u>Tract+surr.area / Non-adjacent areas</u> %Black %Hispanic % Below poverty	-- 1.7 0.6 -- 4.8 -- -- -- -- -- 11.1 3.4 5.9	-- 22.1 4.3 -- 47.5 -- -- -- -- -- 81.6 46.6 45.0	Race, ethnicity and poverty findings only considered significantly larger near sites when the community of concern is considered the site Tract plus immediately adjacent area and reference area is non- adjacent area. Hispanic populations considered somewhat greater nearer sites.
Greenberg	<u>Benefit (service areas) vs. non-benefit areas (towns)</u> % of towns with higher income than service area % of towns with higher minority than service area	36.8 --	61.0 —	

Author(s)	Measure	Absolute Difference	Percent Difference	Author Inference
National Studies				
Hamilton	<u>Areas with/without TSDF expansion</u> %Nonwhite %Poverty	7.0 3.0	38.9 27.3	TSDF areas targeted for expansion had greater nonwhite and poor than those not expanding.
Heitgard, Burg and Strickland	1 mile from site/ rest of site county <u>Table 1 of ref.</u> %Black %Hispanic <u>Table 2 of ref.</u> %Black %Hispanic	-- 5.4 1.1 0.3	-- 60.0 13.3 7.5	Black and Hispanic populations were greater in areas within 1 mile of NPL sites than in the rest of the counties in which sites were located.
Hird	<u>Counties with NPL/ ave. for all counties</u> % Nonwhite %Poverty	-- --	-- --	Population characteristics did not differ for counties with and without NPL sites.

Author(s)	Measure	Absolute Difference	Percent Difference	Author Inference
National Studies				
Perlin et al.	Aggregate Emissions (White/Non-White) 50 %ile Black Native American Asian Other Hispanic 90 %ile Black Native American Asian Other Hispanic	000s lbs. 904 -- 1043 1194 712 8658 -- 20313 21963 21289	000s lbs. 77.8 -- 89.8 102.8 61.3 110.6 -- 259.6 280.6 272.0	Compared to white populations, most minority populations considered to be near areas with substantially greater (many times greater) TRI emissions.
Ringquist	TSDFs/no TSDFs % Minority 1+ TSDF 5+ TSDF % Poverty	 8.0 17.0 --	 72.7 154.5 --	“. . . race continued to be an important predictor of facility location but that poverty was not” for TSDF sites.
Ringquist	Aggreg. 1987-1991 emissions (000s lbs.) <u>High/Low Minority</u> 5-25% Min. >25% Min. <u>High/Low Poverty</u> 5-25% Poverty >25% Poverty	 10.1 14.3 -- --	 100.0 141.6 -- --	“. . . as the percentage of all minorities in a neighborhood increases, so does the level of toxic pollution. On the other hand, TRI releases appear to be unrelated to poverty or to the percentage of Latino residents in a neighborhood.”

Author(s)	Measure	Absolute Difference	Percent Difference	Author Inference
National Studies				
UCCCRJ	<u>TSDF/no TSDF</u> % Minority 1+ TSDFs 2+ TSDFs	12.0 26.0	100.0 216.7	“. . .as the percentage of poor and minority residents of a neighborhood increases, so does the likelihood that the neighborhood has a TASDF. In addition, race was a stronger predictor than poverty. This relationship between race and facility location held even when controlling for region, urbanization and land value.”
Zimmerman	<u>Site municipality/</u> <u>U.S.(population weighted %s)</u> %Black % Hispanic % Poverty	6.6 4.7 1.6	54.6 34.3 7.8	“. . .Black populations were approximately 50% higher than the analogous proportions in the nation as a whole.” “Hispanics . . . are relatively more prevalent in communities with NPL sites than they are in the nation as a whole.” . . .the association of severe poverty with NPL site location is less pronounced than race and ethnicity is.”

BIBLIOGRAPHY

- Anderson, A.B., D.L. Anderton and J.M. Oakes, "Environmental Equity: Evaluating TSDF Siting Over the Past Two Decades," *Waste Age* (July 1994), pp. 83-84; 86-100 (alternate pages).
- Anderton, D.L., A.B. Anderson, J.M. Oakes and M.R. Fraser, "Environmental Equity: The Demographics of Dumping," *Demography*, Vol. 31, No. 2 (May 1994), pp. 229-248.
- Anderton, D.L., et al., "Hazardous Waste Facilities. "Environmental Equity" Issues in Metropolitan Areas," *Evaluation Review*, Vol. 18, No. 2 (April 1994), pp. 123-140.
- Boerner, C. and T. Lambert, "Environmental Justice in the City of St. Louis: The Economics of Siting Industrial and Water Facilities," St. Louis, MO: Washington University, Center for the Study of American Business, April 1995.
- Bowen, W.M., M.J. Salling, E.J. Cyran, H.A. Moody, "The Spatial Association Between Race, Income, and Industrial Toxic Emissions in Cuyahoga County, OH," Cleveland, OH: Cleveland State University, Levin College of Urban Affairs, 1993. Unpublished manuscript.
- Bryant, B. and P. Mohai, eds. *Race and the Incidence of Environmental Hazards*. Boulder, CO: Westview Press, 1992.
- Castleman, Kristine, "Two Case Studies of the Spatial Relationship between Environmental Risks and Population Groups in Seattle," Seattle, WA: City of Seattle Planning Department, October 1993.
- Coursey, D., "Environmental Racism in the City of Chicago: The History of EPA Hazardous Waste Sites in African-American Neighborhoods," Chicago, IL: University of Chicago, The Irving B. Harris Graduate School of Public Policy Studies, October 1994.
- Cutter, S.L., D. Holm and L. Clark, "The Role of Geographic Scale in Monitoring Environmental Justice," *Risk Analysis: An International Journal*, 16, 5 (August 1996), pp. 517-526.
- Gelobter, M., "Toward a model of environmental discrimination." In: B. Bryant and P. Mohai, eds. *Race and the Incidence of Environmental Hazards*. Boulder, CO: Westview Press, 1992.
- General Accounting Office (GAO), 1983, Siting of Hazardous Waste Landfills and their correlation with Racial Economic Status of Surrounding Communities, Washington, D.C.
- Goldman, B.A. and L. Fitton, "Toxic Wastes and Race Revisited." Washington, D.C.: Center for Policy Alternatives, 1994.
- Greenberg, M.R., "Proving Environmental Inequity in Siting Locally Unwanted Land Uses," *Risk - Issues in Health & Safety*, Vol. 235 (Summer 1993), pp. 235-252.
- Hamilton, J.T., "Testing for Environmental Racism: Prejudice, Profits, Political Power? *Journal of Policy Analysis and Management*, Vol.

- 14, No. 1 (1995), pp. 107-132.
- Heitgerd, J.L., J.R. Burg, and H.G. Strickland, "A Geographic Information Systems Approach to Estimating and Assessing National Priorities List Site Demographics: Racial and Hispanic Origin Composition," *International Journal of Occupational Medicine and Toxicology*, Vol. 4, No. 3 (1995), pp. 343-363.
- Hird, J.A., "Environmental Policy and Equity: The Case of Superfund," *Journal of Policy Analysis and Management*, Vol. 12, No. 2 (1993), pp. 323-343.
- Korc, M. E., "A Socioeconomic Assessment of Human Exposure to Ozone in the South Coast Air Basin of California," *J. Air & Waste Management Association*, 46 (June 1996), pp. 547-557.
- Lavelle, M. and M. Coyle, "Unequal Protection. The Racial Divide in Environmental Law," *The National Law Journal*, Special Investigation (September 21, 1992), 12 pp.
- Liu, F. "Urban Ozone Plumes and Population Distribution by Income and Race: A Case Study of New York and Philadelphia," *J. Air & Waste Management Association*, 46 (March 1996), pp. 207-215.
- Menser, Michael (118 Koshland Way, Santa Cruz, CA 95064). Silicon Valley Study - TRI and EJ. 408 458-4245.
- Ringquist, Evan J., "The Sources of Environmental Inequities: Economic Happenstance or Product of the Political System?" (Paper presented at the 1995 Western Political Science Association annual meeting, Portland, OR).
- Ringquist, Evan J., "Environmental Justice: Normative Concerns and Empirical Evidence," In: *Environmental Policy in the 1990s* (3rd edition), edited by N.J. Vig and M.E. Kraft. Washington, D.C.: CEQ Press, 1997. Pp. 231-254.
- Perlin, S.A., R. W. Woodrow Setzer, J. Creason and K. Sexton, "Distribution of Industrial Air Emissions by Income and Race in The United States: An Approach Using the Toxic Release Inventory," *Environmental Science & Technology*, Vol. 29, No. 1 (1995), pp. 69-80.
- United Church of Christ, Commission on Racial Justice. *Toxic Wastes and Race in the United States*. New York, NY: United Church of Christ, 1987.

- Zimmerman, R., "Environmental Justice Study for CERCLIS Inactive Hazardous Waste Sites not on the National Priorities List in U.S. EPA, Region 2 (New York)," April 1996, 61 pp. plus appendices.
- Zimmerman, R., "Risk and Public Controversy at Hazardous Waste Sites", Final Report to the U.S. EPA, OSWER, January 15, 1992 (revised, February 1992).
- Zimmerman, R., "Issues of Classification in Environmental Equity: How We Manage is How We Measure," *Fordham Urban Law Journal*, Volume XXI Number 3 (Spring 1994), pp. 633-670.
- Zimmerman, R., "An Environmental Equity Study for Inactive Hazardous Waste Sites," Superfund Program for Inactive Hazardous Wastes Sites on the NPL, U.S. Environmental Protection Agency, Region 2 (New York), February 9, 1994. 90 pp. + Appendices.
- Zimmerman, R., "Social Equity and Environmental Risk," *Risk Analysis: An International Journal*, Vol. 13, Number 6 (December 1993), pp. 649-666.
- Zimmerman, R., "Integrating Environmental Justice (EJ) Methodologies into Environmental Impact Assessment," In: "Environmental Challenges: The Next 20 Years," National Association of Environmental Professionals 20th Annual Conference Proceedings. Washington, D.C.: NAEP, 1995.

Appendix C.2.

Summary of Environmental Justice Studies and Their Selected Methodological Characteristics

In order to explore criteria for determining the existence of an Environmental Justice issue based upon race, ethnicity and poverty, the criteria used in existing Environmental Justice studies were reviewed. Seventeen studies were reviewed, most conducted after 1990, and most from peer reviewed publications. Since each study typically consisted of numerous analyses, only selected analyses were reviewed. The studies covered a variety of waste sites, and many geographic regions of the country. The review was not restricted to sites in Region 2, since not enough studies existed that were specific to the Region.

A frequency distributions of the results was constructed for the percentage differences found between communities of concern and reference areas. Separate distributions were constructed for race and ethnicity (combined) and poverty. The distributions shows the following:

- For minorities (Blacks or various other racial groupings and/or Hispanics)
the distribution is very skewed toward very high percentages. Out of about 36 results (more than one result per study), over four-fifths of the results revealed a greater than 20% difference between community of concern and reference area results.
- For poverty
the distribution is very skewed toward small percentages. Out of about 20 results, only one-third showed a greater than 20% difference between community of concern and reference area results.

This suggests that criteria, or cut-off levels, for making EJ determinations might be constructed differently for minority and poverty. Based exclusively on the distribution of percentage differences (not the absolute differences in the percentages) between the communities of concern and reference areas in the studies reviewed, and the narrative interpretations of these differences presented in these studies, the following ranges of cut-off values were found. The upper levels were selected for the Interim Policy because at those levels, virtually all researchers considered the differences between the community of

concern and the reference communities to be significant.

If the relative difference in the minority percentages between the communities of concern and reference communities is

- less than 5%, then the community of concern is Not significantly higher
- between 5% and 8%, then the community of concern is Not Likely to be significantly higher
- between 8% and 20%, then the community of concern is Likely to be significantly higher
- greater than 20%, then the community of concern is Definitely higher

with respect to the Minority Population EJ Factor.

If the relative difference in the low-income percentages between the community of concern and reference communities is

- less than 2%, then the community of concern is Not significantly higher
- between 2% and 5%, then the community of concern is Not Likely to Be significantly higher
- between 5% and 12%, then the community of concern is Likely to be significantly higher
- greater than 12%, then the community of concern is Definitely significantly higher

with respect to the Low-income Population EJ Factor.

It is very important to note that the studies referenced here generally involved large numbers of communities and were performed to determine EJ trends across the population of those communities. They were not performed to determine whether a specific community should be considered to be an EJ community under the terms of the Executive Order, and thus should be subject to whatever actions a government office might choose to take under the terms of the Executive Order. The Region 2 Interim Policy, on the other hand, will be used to look at specific communities and to determine whether each one, individually, has significantly higher minority and/or low-income percentages. The reference communities and the community boundaries will likely be selected much more carefully as well. As a result, it will be prudent for the Region to utilize cut-offs that are more conservative than those selected by the researchers cited here. The Interim Policy uses 25% as a cut-off for each of the demographic factors, slightly higher than those utilized by the researchers. These cut-offs will identify those communities that are significantly higher in minority and/or low-income population, including communities that may not be obviously 'different' to a casual observer.

Summary of Environmental Justice Studies and Their Selected Methodological Characteristics (1)

Author(s)	Agency/ Org.	Date	Facility	Scope	Data Unit	(4) Burden	Area Definition (3)	Comparison Area / or Basis of Comparison
GOVERNMENTAL STUDIES (2)								
Axelrad (3)	U.S.EPA, HQ	1995	Air Toxics	Nation	Tract	Data Unit	Tracts of varying concentrations implied	
Castleman	Seattle Planning Dept.	1993	Parks EHS facility	Seattle	Block; Block Groups	1/4, 1/2 mi. from park boundary; Data Unit	Non-park area of City; Total City Adjacent data units	
Gonzalez (3)	U.S.EPA, HQ	1995	NPL	Nation	Block Group	1 mi. from lat./long (GIS)	n.a.	
Harris (3)	U.S.EPA, HQ	1994	Incin.; cement plants	Sample	Block; Block Group	1 mi. from bldg on site	5 mi., county, State, Nation	
Heitgard	ATSDR	1995	NPL	Nation	Block	1 mi. from boundary	1 mi. NPL area / non-NPL area of county in which NPL located	
Nieves	Argonne	1992	Misc.	Nation	County	Data Unit	Facility / no facility Tracts	
Perlin	U.S.EPA, HQ	1995	TRI	Nation	Block Group; County	Data Unit	County	
Zimmerman	U.S.EPA, Reg.	1994	NPL	NJ, NY	Block	1 mi. from lat./long.	State	
Zimmerman (3)	U.S.EPA, Reg.	1996	non-NPL	NJ, NY	Block	1 mi. from lat./long.	State County	
NON-GOVERNMENTAL STUDIES								
Author(s)	Agency/ Org.	Date	Facility	Scope	Facility	Data Unit	Area Definition	Comparison Area / or Basis of Comparison
Anderton	U Mass.	1994	TSDFs	MSAs	Tract	Data Unit	Facility / no facility Tracts (adjacent tracts in 1-mi. rings around site Tract) and MSAs	
Cutter	U. South Carolina	1994	TSDF NPL TRI	SC	Block Tract	Group; Data Unit	Relative density of facilities by County; Facility / no facility tracts or block groups	

Glickman	RFF	1994	EHSs	Allegheny, PA	Block Group	1-mi. radius around EHS locations	County	
Goldman	UCC	1987	RCRA, NPL	Nation	Zip Code	Data Unit	State, Nation	
Goldman	CPA	1994	RCRA, NPL	Nation	Zip Code	Data Unit	State, Nation	
Greenberg	Rutgers	1993	WTEF	Nation	Town	Data Unit	Service Area	
Hird	U. Mass.	1994	NPL	Nation	County	Data Unit	Counties without NPLs	
Hamilton	Duke U.	1993 1995	TSDF expansion	Nation	Zip Code; County	Data Unit	Zip codes / counties without TSDFs	
Lavelle	NLJ	1994	NPL	Nation	Zip Code	Data Unit	Minority / non- minority Zip codes containing NPL sites	
Tomboulion (3)	UWCS	1995	Misc.	Detroit	Tract	Data Unit	Adjacent Tracts / Regions in and around Detroit	
Author(s)	Agency/ Org.	Date	Facility	Scope	Facility	Data Unit	Area Definition	Comparison Area / or Basis of Comparison
NON-GOVERNMENTAL STUDIES								
Zimmerman	NYU	1993	NPL	Nation	Municipality	Data Unit (Place/ MCD)	Nation; region	

ABBREVIATIONS:

ATSDR: Agency for Toxic Substances and Disease Registry
 EHS: Extremely Hazardous Substances
 EJ: Environmental Justice
 EPA: Environmental Protection Agency
 MCD: Minor Civil Division
 MSA: Metropolitan Statistical Area (Census designation)
 NLJ: National Law Journal
 NPL: National Priority List (of inactive hazardous waste sites)
 TRI: Toxic Release Inventory
 UCC: United Church of Christ
 UWCS: United Way Community Services
 WTEF: Waste-to-Energy Facility

NOTES:

- (1) The studies reviewed encompass cross-sectional (point in time) studies only. A few time series studies exist as well. These have all been performed at the Tract level, usually comparing Tracts with facilities with Tracts without facilities in a relatively confined geographic area. Two examples of statistical studies conducted using time series data are the study by Coursey (1994) of the Chicago metropolitan area and the study by Boerner and Lambert (1995) of the St. Louis metropolitan area. Problems of comparability of data sites often arise in these time series analyses.
- (2) Numerous inventories of various kinds of facilities and the surrounding demographics have been compiled by U.S. EPA regions using GIS at the Block and Block Group levels. These are not included here primarily because documentation is either currently in process or does not exist for the inventory. Many of the ones compiled by Zimmerman (1993) for the regions were still ongoing as of this writing.
- (3) These studies are not yet publicly available, and are currently under review within U.S. EPA.
- (4) Data Unit: This term signifies a data unit that is used to characterize the demographic characteristics of the area within which the facility or site is located and any burden areas. These units are then aggregated based on the criteria used to define the burden area (see note 5 below). It is usually defined by a data unit used by the U.S. Bureau of the Census, e.g., a Block, Tract, Zip Code. Very often the entire data unit in which a facility or site is located is used to characterize the location of the facility or site, instead of using a point (defined by a latitude/longitude).
- (5) Burden Area Definition: The area assumed to be affected by the facility or site. This is rarely based on health or environmental information directly, and is usually assumed to be some constant distance from the facility or some other area surrounding the facility. "Data unit" is used to indicate the burden area, in cases where the Census unit (e.g., Tract, Zip Code or Block Group) is assumed to comprise the burden area.

APPENDIX D.

SPECIAL CONSIDERATIONS

a. Introduction

In spite of the need to develop consistent and comprehensive methodologies for EJ analyses, there will always be exceptions and situations that are not easily adaptable to a prescribed methodology. The two most common examples occur when:

- The population is homogeneous with respect to one of the EJ factors. In this Region, the clearest example of this is Puerto Rico, in which nearly the entire population is Hispanic, an identified 'minority.'
- The source of exposure or risk is not a small area or discrete point (as in the case of non-point source surface runoff) or is really a combination of sources.

These and other related complex scenarios are explained in the following paragraphs.

b. Special Demographic Considerations

In certain circumstances, a Community of Concern may be virtually indistinguishable from any of its neighbors for a given EJ demographic factor. The classic example in Region 2 is in Puerto Rico, where every community is considered to be Hispanic, even though additional racial differences may exist. A related example would be a community that is not higher in minority representation than the reference communities when all minority groups are considered, but may have significantly greater minority representation when only a single minority group is considered.

i. Population is Homogeneous for One Demographic Factor

When the population in the larger area incorporating the Community of Concern is homogeneous for a given EJ demographic factor, it is not useful to compute a difference in that factor between the Community of Concern and the reference communities. It also would not make sense to exclude the possibility that a community could be an EJ Community simply because all of its neighboring communities share a given EJ factor. Therefore, in cases in which a factor is the same for the Community of Concern and reference areas, the policy is to document that the factor in question is canceled out and continue evaluating the remaining factors. In Puerto Rico, for example, the Hispanic factor would be canceled out, and the EJ determination would be based on the outcome of the low-income factor, any other minority differences (although even this analysis is very difficult because the Census does not collect or report data on race in Puerto Rico), and the disproportionate burden factor.

In Puerto Rico, for EJ screening level studies that may be related to agency enforcement actions, the entire Island should be treated as the reference area. The whole island, or even areas in the mainland, should also be used as the reference area(s) when the source of concern is a military installation, a commercial hazardous waste facility, or an experiment to demonstrate new and innovative technology (in the past, experiments with agent orange and birth control pills have been performed on the island).

ii. Population has High Representation of a Specific Minority Group within an Overall Minority Community

It is likely that there will be situations in which a Community of Concern has a significantly higher percentage of a *particular* minority group than do the reference communities, but does not have a significantly greater percentage of total minority representatives. In such a Community of Concern, that particular minority group may be treated separately, and the EJ determination based on the relative representation of that group, irrespective of the relative percentages of minorities, in toto, in the communities.

For example, say there is a metropolitan area for which each local community has a total minority representation of about 50%, including the Community of Concern. However, in the Community of Concern, the Native American population constitutes about 40% of the total population, while in the reference communities, Native Americans constitute only about 20%, with other minority groups making up the rest of the minority populations. The Native American population in the Community of Concern would be twice the percentage in the reference communities. In this case, the Community of Concern would be judged to satisfy the Minority Population Decision-criterion for the Native American population, even though the overall minority percentages in the Community of Concern and reference communities are about the same.

This example demonstrates that an EJ determination may be based on either the cumulative minority representation within a specific community or on the representation of a specific minority group within the community, regardless of the overall minority representation. The choice will usually be determined a priori by the circumstances surrounding the original decision to investigate that community.

c. Special Environmental Considerations

Making a determination about disproportionate environmental burden is a complex task requiring a series of decisions based on environmental data. This task is made even more complex when the sources of the burden are area-wide rather than point-based, or when a number of sources or parameters overlap. From a human health standpoint, the risks due to exposure from non-point sources are thought to be relatively low. From a cumulative exposure standpoint (see Section 4.e Cumulative Exposure), however, compounded exposures can and may have untold synergistic (or antagonistic) effects. To the extent possible or practicable, all known types of potential sources of exposure from point sources and non-point sources should be given some consideration in the decision making process.

In order to characterize potential exposures more accurately, unconventional exposure scenarios also need to be evaluated (i.e., sources other than single stationary industrial generators). EPA has been reasonably successful in regulating point source pollution largely because they are significantly easier to identify and target for control efforts. Controlling non-point source pollution, on the other hand, has met with limited success. Non-point sources by their very nature are diverse, and as the name would indicate, not generated from a single discrete area. Also, the site(s) of burden can be hundreds of miles away from the area where the pollutants originated. It is also not uncommon for these sources to cross contaminate media. Examples of non-point sources are:

- Air pollutants from mobile sources, fugitive emissions, and emissions from small or non-permitted facilities (e.g., dry cleaners).
- Water pollutants from storm water, urban and agricultural run-off, fugitive draining and groundwater contamination from waste sites.

i. Air Quality Issues

The geographic area of concern is liable to be subjected to any number of environmental threats to air quality from a variety of sources. As mentioned previously, the proximity of so-called “unconventional sources” should be taken into account to fully characterize possible exposure scenarios. These may include but are not limited to:

- Heavily traveled roads and highways
- High capacity parking lots (e.g., at stadiums or shopping malls)
- Toll plazas
- Airports
- Train and bus stations
- Cruise ship docks
- Industrial loading zones

While these sources can be readily identified during a careful inventory of the area, their burden is not easy to estimate or document. An even more difficult task lies in identifying the less obvious contributors to diminished air quality and estimating their potential health burdens, such as: dry cleaners, mismanaged construction areas, aerial pesticide application, outboard motors and lawn and garden treatments (note that these sources can affect water quality as well).

ii. Water Quality Issues

Non-point source water pollution is the largest contributor to the degradation of water quality in the country. Snowmelt or rainfall moving over land and through the ground picks up natural and manmade pollutants eventually depositing them into lakes, rivers, streams, wetlands, coastal waters, and groundwater resulting in potential health risks for populations using these water bodies for consumption, recreation, and subsistence fishing. Deposition of pollutants may also result in damage to surrounding ecosystems due, primarily, to bacterial contamination and eutrophication. Typical sources affecting water quality can include:

- fertilizers, herbicides and insecticides from agricultural and residential applications;
- oil, grease, salt and toxic chemicals from urban runoff and energy production;
- sediment from mismanaged construction sites, crop and forest lands, and eroding stream banks;
- salt from irrigation practices and acid drainage from abandoned mines;
- bacteria and nutrients from livestock, pet wastes and defective septic systems.

Few analytical techniques exist for determining the potential burdens or health hazards that may be associated with polluted runoff or air exposures (see Section 4.f. on Cumulative Exposure). One method for addressing the potential health risks from these sources is to employ the use of fate/transport or dispersion modeling. EPA's Office of Health and Environmental Assessment in the Office of Research and Development has developed the Exposure Models Library (EML) and Integrated Model Evaluation System (IMES) on compact disc.³ Through the use of dispersion modeling and risk assessment, the potential burdens can be determined (depending on data quality) with a reasonable amount of confidence, assuming that the number, type, and size of the specific sources has been determined. This is not always a valid assumption.

³The CD was developed to provide a more efficient means of distributing exposure models, associated documentation and a database of models used for exposure assessments in various media.

Over ninety (90) models are available on this CD which may be used for exposure assessments and fate/transport modeling. The model files contain source codes, sample input files, sample output files, and in some cases, model documentation in WordPerfect or ASCII format. The disc also contains the IMES database, with information on selecting an appropriate model, literature citations for model validation in actual applications and a demonstration of a model uncertainty protocol.

IMES was developed to assist in the selection and evaluation of exposure assessment models and to provide model validation and uncertainty information on various models and their applications. IMES is comprised of three (3) elements: a query system for selecting exposure models in various environmental media (Selection); a database containing validation and other information on applications of exposure models (Validation); and, a database demonstrating application of a model uncertainty protocol for simulations involving six (6) water models (Uncertainty).